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Los-Based Resource Allocation Management In UAV-Assisted Vanets

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Abstract -In Vehicular Ad Hoc Networks (VANETs), Road-Side Units frequently face significant congestion during peak traffic hours due to high vehicle density, which can impact communication quality. Integrating Unmanned Aerial Vehicles (UAVs) enhances network communication by establishing Line-of-Sight connectivity, ideal for high-density urban environments where direct vehicle-to-vehicle communication is often obstructed. A coordinated resource allocation scheme, based on Line-of-Sight in UAV-assisted Vehicular Ad Hoc Networks, improves connection reliability, minimizes interference, and maximizes channel efficiency. By prioritizing Line-of-Sight channels, this approach alleviates Road-Side Unit congestion by redistributing load to UAVs. The results are shown with reduced latency, increased throughput, and enhanced network performance in Intelligent Transportation Systems (ITS).

Key Terms— VANETs, RSUs, UAVs, LoS connectivity, resource allocation.

I. INTRODUCTION

In modern Intelligent Transportation Systems (ITS), ensuring reliable and efficient communication is crucial, particularly in dense urban environments. Vehicular Ad Hoc Networks (VANETs) enable vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, but face significant challenges, including high mobility, interference, and non-line-of-sight (NLoS) conditions, which degrade communication quality and stability.

Unmanned Aerial Vehicles (UAVs) offer a promising solution by providing aerial support for Line-of-Sight (LoS) communication, improving coverage, network resilience, and reducing path loss. However, effective channel and resource allocation remain complex due to the dynamic nature of VANETs, limited UAV resources, and fluctuating channel conditions.

This research proposes a LoS-based coordinated resource allocation framework, dynamically balancing network load between UAVs and Road-Side Units (RSUs). By adjusting UAV and RSU roles based on real-time traffic density and environmental factors, this approach ensures consistent coverage, prevents RSU congestion, and maintains robust, interference-free communication.

Additionally, a probabilistic access mechanism is introduced, prioritizing high-quality communication links based on LoS probability and SINR. This reduces back-off delays in high-density areas while improving network scalability from metropolitan to semi-urban settings. Furthermore, the system leverages historical traffic data and vehicle movement patterns to predict congestion hotspots, proactively distributing resources and optimizing communication performance.

II. SCOPE OF THE PROJECT

The scope of this project is to develop a UAV-Assisted Protocol that enhances resource allocation by integrating Unmanned Aerial Vehicles (UAVs) and Road-Side Units (RSUs). This project addresses RSU congestion during peak hours, exacerbated by high vehicle density in urban areas. Additionally, it tackles interference issues arising from shared RSU-UAV communication channels, which can degrade service quality.

To overcome these challenges, the project proposes a coordinated strategy, leveraging UAVs to support RSUs and improve overall network performance. A key innovation is the probabilistic access mechanism, which dynamically allocates channels based on Line-of-Sight (LoS) connectivity and real-time network conditions, ensuring optimal vehicle service. Furthermore, a cooperative resource allocation platform is introduced to adapt dynamically to traffic density and link quality, optimizing UAV utilization while alleviating RSU congestion. Performance evaluations will be conducted through simulations, comparing the proposed UAV-assisted protocol with non-coordinated approaches. Additionally, this project explores advanced resource management strategies for Intelligent Transportation Systems by integrating machine learning techniques to enhance network adaptability. The applicability of the protocol will be examined across urban and rural environments, ensuring robustness and effectiveness.

III. EXISTING SYSTEM

Traditional VANETs rely on direct V2V connections and ground-based infrastructure, but obstacles like buildings and vehicles often cause NLoS scenarios, degrading communication quality. While techniques like spatial multiplexing and frequency reuse help with resource management, they struggle in highly dynamic environments and fail to leverage UAV-assisted networks effectively. Many existing channel allocation methods overlook LoS conditions, leading to increased interference, inefficient resource utilization, and poor QoS, especially in dense urban areas.

Limitations of Existing System:

Lack of UAV Support: Urban environments suffer from frequent signal obstructions, weakening connectivity.

Inefficient Resource Allocation: Ignoring LoS conditions results in higher interference and poor spectral efficiency, increasing latency.

No Adaptive Management: Without real-time adjustments, networks face congestion in high-density areas.

Limited Scalability & Reliability: These challenges hinder VANET expansion and its effectiveness in Intelligent Transportation Systems (ITS).

IV. LITERATURE SURVEY

L. Gupta, et al., (2016) **[1]** Unmanned Aerial Vehicle networks, have garnered attention for their potential in critical applications such as emergency response, environmental monitoring, and military operations. Multi-UAV networks offer greater coverage, flexibility, and resilience compared to single-UAV systems by leveraging adaptable topologies like mesh networks, which facilitate direct inter-UAV communication. Mesh networks, in contrast to centralized star configurations, reduce latency and prevent single points of failure, enhancing overall network reliability and scalability. Nevertheless, the dynamic nature of UAV networks requires specialized protocols to maintain seamless connectivity and manage high mobility, energy constraints, and intermittent links.

Limitations:

• High mobility and dynamic topology leading to frequent connectivity disruptions.

• Limited energy supply in UAVs, necessitating energy-efficient protocols.

• Existing VANET protocols are insufficient for UAV-specific challenges.

M. Ismail et al., (2023) **[4]** This study introduces an innovative vehicle network design that uses overlapping content delivery strategies between Road Side Units and UAVs. The system leverages the diverse capabilities of RSUs and UAVs to deliver content efficiently in vehicular networks. Simulations confirm that this approach improves throughput and optimizes network structure, supporting intelligent transportation systems through improved content delivery throughput and efficient network resource utilization.

Limitations:

• Power management for UAVs remains challenging.

• Energy demands complicate real-world implementation.

N. Madan et al., (2020) **[5]** This research introduces flying fog units to aid in resource allocation within autonomous and connected vehicles, particularly in congested urban areas. The flying fog units, powered by UAVs, support real-time data processing and resource management, reducing wait times and improving overall system efficiency. The study showed a 9% increase in system efficiency, indicating potential for enhanced end to-end connectivity and reduced traffic delays.

Limitations:

• Limited real-world validation.

• Connectivity challenges in UAV-based vehicular networks.

W. Fawaz et al. (2018) **[6]** This paper presents a mathematical model analyzing the effects of path loss, fading, and irregular vehicle distribution in non-cooperative VANETs. It offers insights into improving V2V connectivity and service performance.

Limitations:

- Not applicable to cooperative VANETs.

V. PROPOSED SYSTEM

When a vehicle enters a new road section, it first enters a decision state, where it evaluates available channels for communication. The selection process is influenced by the probability of Line-of-Sight and Non-Line-of-Sight connectivity. If the LoS probability is greater than 0.5, the channel is assigned through a UAV; otherwise, the Roadside Unit manages the allocation.

In cases where access is unsuccessful, the vehicle enters a waiting phase with a gradually decreasing timer before attempting to reconnect. This adaptive approach improves channel allocation in high-traffic areas by dynamically adjusting resources based on LoS conditions. By employing a probabilistic access method, the system reduces strain on RSUs and effectively utilizes UAVs in congested zones, preventing unnecessary resource consumption often observed in non-coordinated methods.

Advantages of Proposed System:

Higher Throughput for UAVs: UAVs achieve superior throughput compared to RSUs due to their favourable Line-of-Sight (LoS) communication in dense traffic areas.

Load Balancing: The system efficiently balances load between RSUs and UAVs by adjusting the LoS probability threshold for channel allocation.

Reduced Interference: Probabilistic access and SINR thresholds significantly reduce interference compared to non-coordinated systems.

Efficient Resource Allocation: Dynamic allocation of channels based on LoS probability optimizes resource utilization.

Mitigation of Congestion: The UAV-Assisted Protocol alleviates channel congestion on RSUs in high-traffic scenarios.

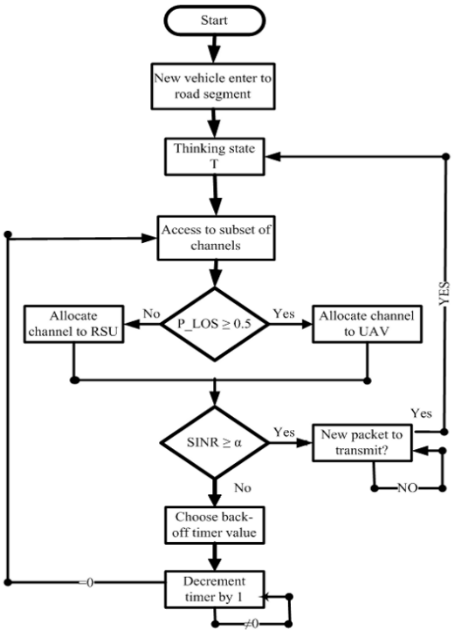

Figure 1: Proposed System

VI. SYSTEM ARCHITECTURE

The Figure 2 illustrates a LoS/NLoS-based resource allocation framework involving a server, UAVs, RSUs, and vehicles. Vehicles with LoS connectivity to UAVs receive resources from UAVs, while those in NLoS conditions are assigned to RSUs. This adaptive allocation optimizes resource usage, reduces congestion, and ensures seamless communication. The server centrally manages resource distribution between UAVs and RSUs.

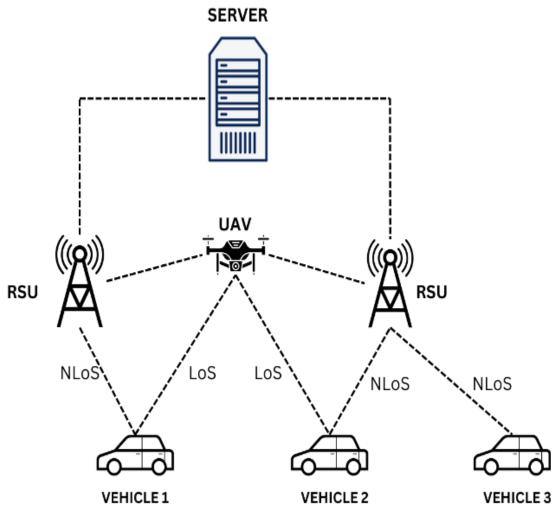

Figure 2: Network architecture of the proposed system

Probabilistic Channel Allocation Based on LoS Probability

Resources are dynamically allocated between UAVs and RSUs based on LoS probability. If the probability exceeds **0.5**, the vehicle connects to a UAV; otherwise, it links to an RSU. This probabilistic approach optimizes resource distribution, reduces congestion, and enhances network performance by utilizing the best available connection.

UAV-Assisted Protocol for Resource Allocation

An adaptive UAV-assisted protocol controls channel access via CSMA/CA, distributing resources based on LoS conditions, traffic density, and vehicle importance. Reliable communication is maintained using routing protocols.

Base Station Control System

Transmission power for UAVs and RSUs is adjusted dynamically based on network density. Unlike traditional power control, this method ensures efficient throughput and supports RSUs during peak loads.

Load Balancing with Threshold Control

Threshold-based control dynamically shifts connections between UAVs and RSUs. Lowering the LoS probability threshold increases UAV connections, easing RSU load, while raising it diverts traffic to RSUs, preventing congestion.

VII. RESULT AND ANALYSIS

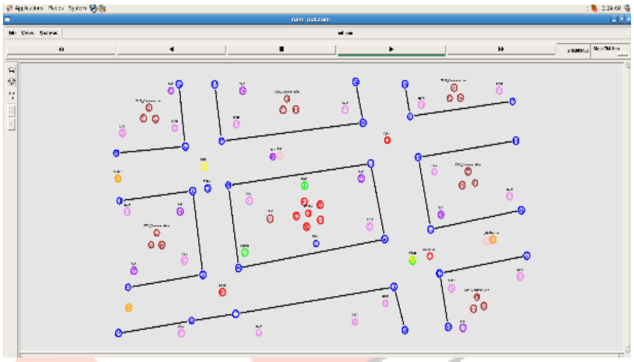

Figure 3: NS-2 simulation of the system

A simulation setup was designed with 100 nodes, including vehicles, Roadside Units (RSUs), UAVs, and environmental structures like buildings. The communication among these nodes is structured to balance the load on RSUs, boost throughput, and improve overall resource allocation. UAVs adaptively reposition to maintain consistent Line-of-Sight (LoS) links with moving vehicles, especially in obstructed areas. Performance is evaluated through key metrics like Packet Delivery Ratio, End-to-End Delay, and Channel Utilization to measure efficiency and reliability.

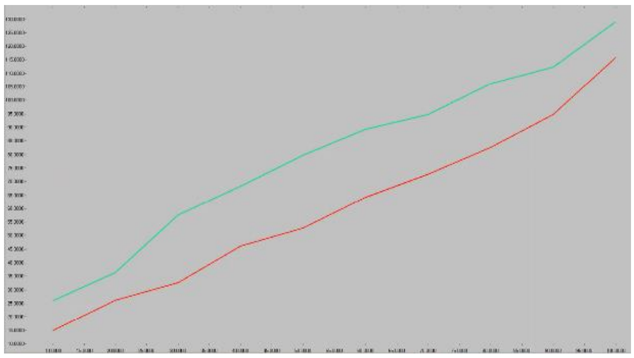

Figure 4: Throughput comparison of the proposed system

The proposed LoS-based framework effectively reduces interference, minimizes latency, and enhances overall network efficiency. It ensures optimal channel allocation, leading to improved connectivity and seamless communication in dynamic vehicular environments.

In the figures, the green line represents the overall result from both UAV and RSU, the blue line corresponds to the UAV and the red line corresponds to the RSU. Figure 4 represents the throughput of the RSU, and the combined RSU-UAV system.

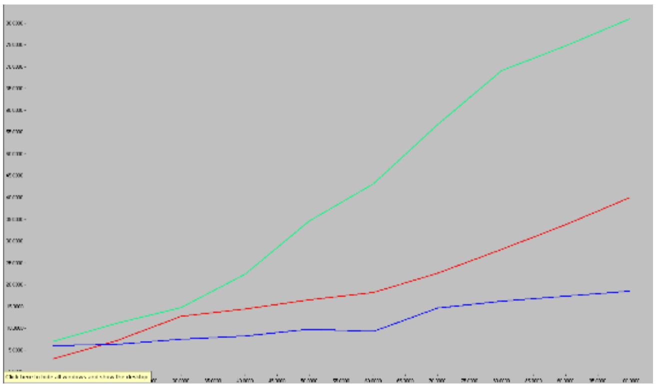

Figure 5: Maximizing the load on UAV

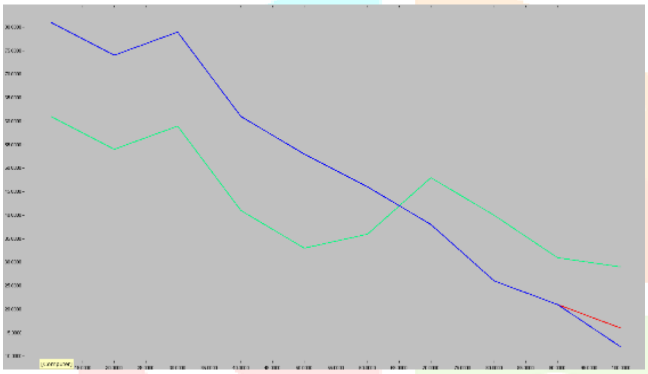

Figure 6: Minimizing the load on UAV

Figures 6 and 7 demonstrate the impact of varying the UAV's channel assignment threshold on load distribution. At p=0.25, a lower threshold results in the UAV handling a greater share of the load, while the RSU's load decreases. At p=0.75, the stricter threshold shifts more of the load to the RSU, reducing the UAV's load.

VIII. CONCLUSION

The proposed method enhances UAV-assisted VANETs by leveraging UAVs as mobile relays to maintain stable LoS communication, reduce latency, and improve throughput in dynamic urban environments. By dynamically adjusting to network conditions, it optimizes spectral efficiency and minimizes interference, ensuring reliable connectivity for Intelligent Transportation Systems.

Future enhancements will focus on autonomous UAV coordination for efficient resource allocation and machine learning-based predictive management to optimize channel distribution. These advancements will enhance scalability, reliability, and network adaptability, contributing to more resilient and intelligent urban communication systems.

IX. REFERENCES

[1] L. Gupta, R. Jain, and G. Vaszkun, "Survey of important issues in UAV communication networks," IEEE Commun. Surveys Tuts., vol. 18, no. 2, pp. 1123–1152, 2nd Quart., 2016.

[2] Z. Shafiq, R. Abbas, M. H. Zafar, and M. Basheri, "Analysis and evaluation of random access transmission for UAV-assisted Vehicular-to-Infrastructure communications," IEEE Access, vol. 7, pp. 12427–12440, 2019.

[3] B. Liu, H. Xu, and X. Zhou, "Resource allocation in unmanned aerial vehicle (UAV) assisted wireless-powered Internet of Things," Sensors, vol. 19, no. 8, p. 1908, Apr. 2019.

[4] M. Ismail, S. L. Shah, F. Muhammad, Z. Shafiq, A. Abdullah, and J. H. Arman, "Efficient content delivery in urban vehicular networks: A hybrid RSU-UAV framework," in Proc. Int. Conf. Recent Innov. Results Eng. Technol., Sep. 2023, pp. 247 252.

[5] N. Madan, A. W. Malik, A. U. Rahman, and S. D. Ravana, "On-demand resource provisioning for vehicular networks using flying fog," Veh. Com mun., vol. 25, Oct. 2020, Art. no. 100252.

[6] W. Fawaz, "Effect of non-cooperative vehicles on path connectivity in vehicular networks: A theoretical analysis and UAV-based remedy," Veh. Commun., vol. 11, pp. 12–19, Jan. 2018.

[7] B.-M. Cho, M.-S. Jang, and K.-J. Park, "Channel-aware congestion control in vehicular cyber-physical systems," IEEE Access, vol. 8, pp. 73193–73203, 2020. 28

[8] E. Steinmetz, M. Wildemeersch, T. Q. S. Quek, and H. Wymeersch, "Packet reception probabilities in vehicular communications close to inter sections," IEEE Trans. Intell. Transp. Syst., vol. 22, no. 5, pp. 2823–2833

[10] M. Mozaffari, W. Saad, M. Bennis, Y.-H. Nam, and M. Debbah, "A tuto rial on UAVs for wireless networks: Applications, challenges, and open problems," IEEE Commun. Surveys Tuts., vol. 21, no. 3, pp. 2334–2360, 3rd Quart., 2019.